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ENVIRONMENTAL MONITORING REPORT ON DEPARTMENT OF ENERGY FACILITIES AT GRAND JUNCTION, COLORADO, AND MONTICELLO, UTAH, FOR CALENDAR YEAR 1984

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Grand Junction, Colorado

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Section I

SUMMARY

GRAND JUNCTION PROJECTS OFFICE FACILITY

The shallow gravel aquifer that underlies the Grand Junction, Colorado, Department of Energy (DOE) facility is contaminated by uranium mill tailings. Uranium, molybdenum, arsenic, and selenium are all found in significantly elevated concentrations. For example, the Safe Drinking Water Act has set limits of 0.05 mg/l arsenic and 0.01 mg/l selenium. Both of these limits are regularly exceeded in groundwater samples collected within 6 meters of the Gunnison River. Selenium levels have been as high as 0.04 mg/l, and arsenic levels as high as 0.4 mg/l. There are no standards promulgated for molybdenum, but the National Academy of Sciences (1972) has suggested a limit of 0.01 mg/l for agricultural use. Wells along the perimeter of the facility, many within a few meters of the river, contain approximately 0.3 mg/l molybdenum, and one well near the buried tailings area contains 2.6 mg/l. Uranium levels correlate well with those of molybdenum except that they are significantly greater, with several wells on the river dike containing more than 1 mg/l.

Surface water on the facility consists of two lagoons and a drainage ditch. The most serious contamination detected in 1984 was radium-226 in the ditch adjacent to the river dike. Results of the August sampling indicate a radium-226 concentration in the ditch of 51 pCi/l compared with the standard for drinking water of 5 pCi/l.

Samples were collected from the Gunnison River four times during the year. In no instance were uranium-related contaminants detected in the samples. Thus, the effect of the contaminated aquifer on the river is assumed to be negligible; however, this cannot be verified without additional testing.

In addition to the contamination discussed above, the presence of polychlorinated biphenyls (PCBs) is addressed in this report. Transformers on the facility have been properly labeled, and PCB-contaminated waste was disposed of in 1983.

Because there have been no significant process changes and no air-quality impacts reported in previous years, air-quality data were not obtained in 1984.

MONTICELLO MILLSITE

The shallow aquifer underlying the Monticello, Utah, DOE property is also contaminated by uranium mill tailings. The creek flowing through the property is contaminated at levels exceeding State of Utah water-quality standards for several kilometers downstream from the property. Contamination in Montezuma Creek results from seeps issuing from the contaminated alluvial aquifer. This seepage causes the uranium concentration in the creek to increase by as much as an order of magnitude; concentrations as high as 0.9 mg/l were detected 30 meters from the Government property in 1984. Similarly, selenium concentrations regularly exceed 0.01 mg/l, the Utah standard for this section of Montezuma Creek. Molybdenum concentrations, which average approximately 0.09 mg/l immediately downstream from the site, exceed the recommended limit for agricultural use (National Academy of Sciences, 1972) by about a factor of ten. The creek is used both for irrigation and for livestock watering in the vicinity of the site.

Concentrations in the shallow aquifer generally exceed those found in the surface water. Uranium, molybdenum, vanadium, selenium, and arsenic are all found in concentrations exceeding 1 mg/l in some wells. However, because of the low volume of water in this aquifer, State of Utah standards are apparently not applicable.

Extensive measurements of radon contamination from the tailings piles were conducted during 1984. These include on-pile, site-boundary, and off-site Track Etch measurements, as well as additional on- and off-pile radon-flux measurements. Results of these measurements are not available at this time, but will be presented and discussed in detail in the Environmental Assessment for the Monticello Millsite, being prepared by Bendix Field Engineering Corporation/Grand Junction Operations and scheduled for completion in June 1985.

Section II

INTRODUCTION

This report describes environmental monitoring activities conducted at the U.S. Department of Energy (DOE) Grand Junction, Colorado, Projects Office facility (Section III) and at the inactive uranium millsite in Monticello, Utah (Section IV).

GRAND JUNCTION PROJECTS OFFICE FACILITY

The Grand Junction Projects Office (GJPO) facility encompasses 48.6 acres and lies on the floodplain of the Gunnison River. An earthen dike is located between the facility and the river to the west. Although adjacent land is used primarily for agriculture, the facility is within approximately 1 kilometer of heavily populated areas.

Personnel at the GJPO facility develop, support, and/or administer a variety of programs. Historically, the Office was most heavily involved in uranium procurement, evaluation of domestic uranium resources, and advancement of geologic and geophysical exploration techniques. The scope of activities now includes provision of considerable support to the Government's various remedial action programs and to the Civilian Radioactive Waste Management (CRWM) program. Housed on the GJPO facility are fully equipped laboratories for analytical chemistry, mineralogy-petrology, and electronics. Research groups at the facility have also received funding for specific projects from a variety of entities, including the Environmental Protection Agency and the Department of Defense. Bendix Field Engineering Corporation (Bendix) is the operating contractor for the Government-owned/contractor-operated (GOCO) facility.

No point-source discharges or waste-treatment activities occur on the facility. Uranium milling, analysis, and storage were conducted for a period of 25 to 30 years; these activities ceased in the mid-1970s. All present contamination is believed to be the result of these past activities. One area on the facility has been designated as containing buried tailings; however, results of several surveys (Allen and Abramiuk, 1982) indicate the presence of tailings and buried contaminated equipment at other locations. These buried wastes have resulted in contamination of the alluvial aquifer underlying the facility. The aquifer is believed to be the primary environmental concern and has been the major focus of monitoring activities.

Cleanup of the buried mill tailings at the GJPO facility has been accepted under the Surplus Facilities Management Program (SFMP). Funding for this effort began in FY-1985.

MONTICELLO, UTAH, MILLSITE

Responsibility for administration, maintenance, and environmental monitoring of the inactive uranium millsite and tailings area at Monticello, Utah, formerly operated by the Atomic Energy Commission, resides with the DOE Grand Junction Projects Office. The site was accepted into the Surplus Facilities Management Program in 1980. Under this program, the chief objective of the Monticello Remedial Action Project is to minimize potential health hazards to the public associated with the tailings at the millsite. In order to provide a basis for making remedial action decisions regarding the site, an environmental and engineering characterization was recently completed and is documented in the Monticello Remedial A ion Project Site Analysis Report (Abramiuk and others, 1984).

The Monticello millsite is a 78-acre tract located in San Juan County, Utah, adjacent to the city limits of Monticello. The mill area covers approximately 10 acres and the tailings impoundment area covers the remaining 68 acres. None of the original mill buildings remain, but contaminated foundations and scrap materials are buried on-site. The tailings impoundment area contains almost 2 million tons of tailings and contaminated soil in four separate tailings piles. Results of subsequent surveys indicate the presence of more than 300,000 additional tons of contaminated material on adjacent open lands.

Prior to 1955, the environmental problems receiving attention at the Monticello mill arose from the salt-roast procedure used to enhance vanadium recovery. Studies indicated that an average of nearly 2600 pounds of dust containing 0.363 percent U_3O_8 and 1.52 percent V_2O_5 escaped daily through the roaster stack (Allen and Klemenic, 1954). Corrosion of wire fences, clotheslines, and galvanized roofs was verified by the mill operator in response to complaints from local residents.

Liquid effluent from the salt roast/carbonate leach plant, containing substantial concentrations of chloride, sulfate, carbonate, bicarbonate, sodium, and other dissolved species, was released into Montezuma Creek. Release of radium-226 was of special concern; soluble radium activity in Montezuma Creek was found to be 160 pCi/l. It was also recognized that the suspended solids contained considerable radium activity and that dry tailings were being washed into the creek (Whitman and Beverly, 1958).

During milling operations, the tailings were normally moist so that erosion by wind was minimal. Within a year after shutdown, however, the tailings dams and surfaces of the piles dried out, and tailings sand began to migrate as dunes. Erosion by water also became a problem. Several cleanup activities, conducted since the time of mill closure, have substantially stabilized the area, but have not eliminated water contamination.

Water contamination results from the leaching of uranium mill tailings. Extensive studies conducted at Monticello (Abramiuk and others, 1984) demonstrate that all four tailings piles contribute to the contamination of groundwater and surface water, both on- and off-site.

QUALITY ASSURANCE

Quality Assurance (QA) measures were incorporated into all of the monitoring activities detailed in this report, and were appropriately documented. The general quality assurance policy and procedures, as presented in the Quality Assurance Manual (Bendix Field Engineering Corporation/Grand Junction Operations), were followed. In addition, certain documents were consulted to address QA considerations regarding specific measurement and sample-collection procedures. These include the following:

- Bendix/GJO Handbook of Analytical and Sample-Preparation Methods (Bendix Field Engineering Corporation)

- Bendix/GJO Analytical Laboratories Quality Assurance Manual (Bendix Field Engineering Corporation)

- Procedures for Field Chemical Analyses of Water Samples (Korte and Ealey, 1983)

- Procedures for the Collection and Preservation of Groundwater and Surface Water Samples and for the Installation of Monitoring Wells (Korte and Kearl, 1984)

- Procedures for Reconnaissance Stream-Sediment Sampling (Fleischhauer and Engelder, 1984)

- Procedures for Sampling Radium-Contaminated Soils (Fleischhauer, 1984)

At this time, the specific QA requirements for each project are being defined and will be compiled as the following documents:

- SFMP/Grand Junction Projects Office (GJPO) Quality Assurance Program Plan (QAPP)

- SFMP/Monticello Remedial Action Project (MRAP) Quality Assurance Program Plan (QAPP)

Section III

GRAND JUNCTION, COLORADO, PROJECTS OFFICE FACILITY

AIR QUALITY

No air-quality monitoring activities were conducted at the GJPO facility in 1984. The 1980 and 1981 environmental monitoring reports (Korte and Thul, 1981, 1982) describe air-quality impacts from the sample plant, analytical laboratory, employee automobiles, and the central heating plant. It was concluded that no impacts were observed or expected.

A large chamber for the study of radon measurements was recently constructed at the facility. This chamber releases some radon to the environment. A study of the chamber, its uses and impact, was conducted in 1984 by Langner and Nelson (1985); they concluded that the radon released is insignificant.

Other operations at the GJPO facility do not emit significant quantities of radiation into the atmosphere. The tailings buried on the facility constitute the only major source of radon emission. A Track Etch monitoring system was established in November 1984 to determine the radon contribution from the facility. Results of this year-long study, to be completed in November 1985, will be included in next year's environmental monitoring report.

POLYCHLORINATED BIPHENYL (PCB) MONITORING

During 1982 a program was completed to identify and determine the total quantity of polychlorinated biphenyls (PCBs) and PCB-contaminated fluids on the facility. All facility transformers were opened and oil samples taken. These samples were analyzed in the Bendix Analytical Chemistry Laboratory, based on methods and standards provided by the Environmental Protection Agency. More than 1000 gallons of PCB-contaminated fluids were identified (Miller and Donivan, 1982). All PCB-contaminated labware and waste material (approximately 20.5 pounds) were disposed of during 1983.

WATER QUALITY

SAMPLING PROCEDURES

Water samples were collected at the GJPO facility in February, May, August, and November, 1984. Both groundwater and surface water samples were obtained using a peristaltic pump. Samples were filtered through a 0.45-µm filter in line with the collection vessel. The samples were then preserved and analyzed according to procedures prescribed in Korte and Ealey (1983) and Korte and Kearl (1984). These procedures incorporate the major aspects of procedures published by the Environmental Protection Agency (1979a, 1979b, 1980, 1982a, 1982b) and the U.S. Geological Survey (1977). However, they provide much greater detail and include extensive quality-assurance measures.

SURFACE WATER

Figure III-1 shows the surface water sites sampled in 1984. The North Pond is contaminated principally by uranium; recharge is primarily from the shallow gravel aquifer underlying the facility. Contamination levels are similar to those observed in previous years. Uranium concentrations in the four 1984 samplings averaged greater than 0.5 mg/l.

The South Pond ('Lagoon' on Figure III-1), also recharged primarily by the shallow gravel aquifer, was formerly used as a sewage lagoon. Currently, its principal source of effluent is storm runoff from the parking lots. Variable contamination by uranium has been observed: The sample collected in December 1983 contained nearly 0.1 mg/l; the February 1984 sample contained only 0.06 mg/l; while the May 1984 sample, collected following a very rainy Spring, contained 0.55 mg/l. This last value decreased to 0.3 mg/l by the time of the August sampling. Clearly there is a need for additional hydrologic testing to determine the cause of these fluctuations.

Previous environmental monitoring reports refer to a sampling location known as the drainage ditch. This area is located outside the facility fence directly west of the buried tailings area and below the river dike. Formerly, the South Pond overflowed into the ditch more or less continuously; however, it has been observed on numerous inspections that the pond has not contained sufficient water to overflow since the facility was connected to the city sewer system in 1981. Nevertheless, water remains in the ditch area except during very dry seasons. Results of chemical analysis of the ditchwater indicate some substantial fluctuations since the South Pond overflow ceased. Radium-226 was not detected in 1982, was as high as 59 pCi/l in 1983, and averaged 46 pCi/l in 1984. The concentrations of uranium and molybdenum also remain high, the former exceeding 1 mg/l and the latter exceeding 0.4 mg/l.

The Gunnison River was sampled upstream, downstream, and alongside the facility during each of the four sampling periods in 1984. Uranium-related contaminants were not detected in these samples, nor were significant differences in the three locations noted for any of the sampling periods. Slight increases for a few ions are evident, but the differences are not sufficient to suggest contamination from the site.

The level of water in the ditch rises and falls with the level of water in the river; thus, there is a strong likelihood that contaminated water enters the river. Apparently, the volume of water in the river is sufficient to quickly dilute contaminants to background levels. The 1981 environmental monitoring report (Korte and Thul, 1982) describes some weak evidence for river contamination; this is explained in part by the lower average flows in the river in 1981 relative to 1984. River flows for the sampling dates in 1984 ranged from 2394 to 13,103 cubic feet per second (cfs).

An additional problem in assessing possible contamination of the Gunnison River results from the method used for sample collection. All the river samples have been 'grab' samples collected from the riverbank; yet studies demonstrate that this type of sample does not yield an accurate picture of the concentration of material in a river (see, for example, Jaffe and others, 1982). A more extensive sampling study is planned in order to determine whether the river is affected by contaminants leaching from the GJPO facility.

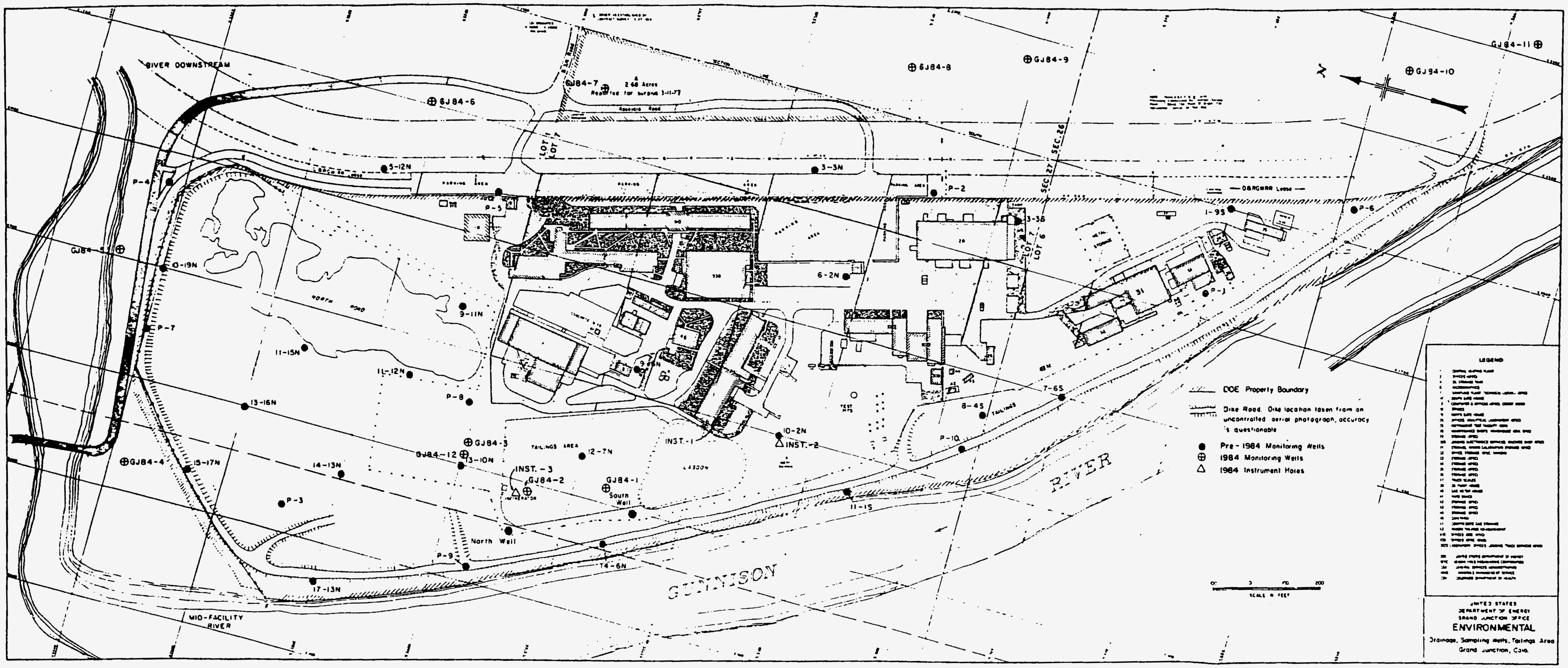


Figure III-1. Locations of Drainage, Sampling Wells, and Tailings Area at the Grand Junction Projects Office Facility

GROUNDWATER

Analytical results on samples from the groundwater monitoring wells are also described empirically; the data cannot be interpreted in a quantitative manner until additional hydrologic and chemical testing are completed.

Based on results of the 1981 data, Wells P-2, P-6, 1-9S(D), 3-3N(D), and 5-12N(D) (Figure III-1) were expected to represent background. (The designation 'D' denotes a two-well multilevel system at the particular location.) Results of subsequent samplings, however, indicate that this assumption is erroneous. Uranium levels in P-2 and P-6 reported in the 1981 report were less than 0.01 mg/l. During 1982, 1983, and 1984, samples from all five wells contained levels of uranium above the expected background concentration. Uranium contents ranged from approximately 0.02 mg/l in P-2 to more than 0.8 mg/l in the shallow well at location 1-9S. Except for Well 1-9S, the concentration of uranium ranged from 0.02 to 0.06 mg/l. Other anomalies also exist. For example, selenium was detected in Wells 5-12N(D) and 1-9S(D); contamination by zinc, vanadium, and manganese is evident in one or more wells. Thus, it is now believed that none of these five wells represents background. For that reason, additional wells were drilled in 1984 (Sewell and Price, 1984); they are denoted by the prefix GJ84-. Available data indicate that Wells GJ84-9, 10, and 11 represent background (Table III-1).

Table III-1. Concentrations of Selected Elements in the GJ84 Monitoring Wells

Well	Contaminant Concentration[a]					
No.	U	Mo	As	Se	Ra-226	NO_3-N
GJ84-1	0.027	<0.05	0.1	<0.01	4.2	0.4
GJ84-2	0.068	0.06	0.09	<0.01	3.5	<0.1
GJ84-3	1.1	0.74	<0.01	<0.01	<2	<0.1
GJ84-4	0.7	0.36	<0.01	<0.01	<2	<0.1
GJ84-5	0.6	0.2	<0.01	<0.01	<2	<0.1
GJ84-6	0.028	<0.05	<0.01	<0.01	<2	<0.1
GJ84-7	0.117	<0.05	<0.01	0.05	<2	<0.1
GJ84-8	0.014	<0.05	<0.01	<0.01	<2	0.4
GJ84-9	0.006	<0.05	<0.01	<0.01	<2	<0.1
GJ84-10	0.004	<0.05	<0.01	<0.01	<2	<0.1
GJ84-11	0.010	<0.05	<0.01	<0.01	<2	<0.1
GJ84-12	0.8	0.46	0.017	<0.01	<2	2.8

[a]All results are in mg/l, except Ra-226 which is in pCi/l. These are average values for two samplings, August and November.

The discussion that follows focuses on individual contaminants (cf. Figure III-1 for location information).

Uranium contamination is evident in all wells except those new wells that represent background (GJ84-9, 10, and 11). Twenty-six wells contained more than 0.5 mg/l uranium in at least one of the sampling periods. The highest concentrations were found in Wells 8-4S and P-10, which are located west of Building 3022. The uranium levels in most of the other wells were greater than 0.1 mg/l. The average concentration in the wells along the north dike has remained fairly consistent over the past 3 years. Average uranium concentrations of 0.81 mg/l in 1982, 0.88 mg/l in 1983, and 0.86 mg/l in 1984 were determined from data for Wells P-4, 10-19N, P-7, and 15-17N; data from new wells GJ84-4 and 5 were included in the 1984 averaging. The uranium concentrations along the west boundary (Wells 11-1S, P-10, 7-6S, and 8-4S) were at least 2 mg/l in each of the four sampling periods in 1984, with a high value of 4.8 mg/l. Several of these wells are located on the river dike.

Molybdenum contamination is also widespread throughout the monitoring system. The highest concentration in 1984 occurred in Well 8-4S, exceeding 2.3 mg/l on two occasions. Several other wells (10-2N, P-1, 13-10N, 13-16N, 15-17N, GJ84-3, and GJ84-12) consistently averaged greater than 0.5 mg/l throughout the year.

Arsenic contamination is localized in the vicinity of the buried tailings area. In the February sampling, Wells 14-6N, 13-10N, and 12-7N contained from 0.11 to 0.4 mg/l. For the remainder of the year, arsenic levels were below 0.1 mg/l for these wells and several surrounding wells (11-12N, GJ84-1, and GJ84-12).

Selenium contamination appears to be greatest in the south end of the facility. Data from Wells 3-3S, 10-2N, 6-2N, 1-9S, 8-4S, 7-6S, and P-1 indicate an average of 0.05 mg/l in the February, May, and November samplings. Results from the August sampling range from 0.05 to 0.2 mg/l.

Although the potential for radium contamination is always a concern due to the nature of the buried waste, the conditions of high pH, high sulfate, and low barium in the alluvial aquifer lead to little or no radium migration. In fact, radium was detected only in the dike ditch and in Well 8-4S in May, and in Wells GJ84-1 and 2 in August.

The drinking water standard for nitrate-nitrogen is 10 mg/l, and several wells showed concentrations exceeding this limit. All of these wells are located roughly between Wells 8-4S (west of Building 31) and 11-12N(D) (near the North Pond). None of the perimeter wells contains high levels of nitrate.

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) MONITORING

Quarterly monitoring, in compliance with requirements of the Resource Conservation and Recovery Act (RCRA), was initiated in November 1984. One of the new wells, GJ84-9, is being sampled as background. Wells GJ84-4 and 5, 15-17N, 10-19N, and 17-13N are being sampled as downgradient wells. No results are available at this time, but they will be included in next year's environmental monitoring report.

COLORADO WATER-QUALITY STANDARDS

State of Colorado water-quality standards, as specified in the Colorado Water Quality Control Act, were reviewed with respect to contamination detected on the GJPO facility. Table III-2 presents the range of numerical standards for some of the contaminants found in the underlying gravel aquifer. There is no Colorado standard for molybdenum; however, the National Academy of Sciences (1972) has recommended an agricultural-use standard of 0.01 mg/l.

Table III-2. Colorado Water-Quality Standards for Selected Elements

Element	Maximum Contaminant Level (depending on use class and alkalinity)
Arsenic	0.05 - 0.1 mg/l
Selenium	0.01 - 0.05 mg/l
Uranium	0.03 - 1.4 mg/l
Radium-226 and -228	5.0 pCi/l

As the table demonstrates, application of these standards is complicated by the promulgation of varying contaminant levels for many trace elements, the applicable standard being dependent on the use classification and alkalinity of the water. The thrust of the Colorado statute is to clean up existing polluted waters and to prevent further degradation of any State waters. The shallow gravel aquifer underlying the GJPO facility is contaminated at levels that make it unfit for agricultural purposes, the lowest use class defined. However, the language in the Act seems to exempt past practices. In other words, since the shallow aquifer is not being used for any purpose, it may be interpreted that the Department of Energy is not mandated to clean it up. On the other hand, existing operations are not permitted to cause further degradation.

Contamination of the Gunnison River is another matter. The regulations clearly prohibit any facility from degrading the quality of a State river. Hence, it is important to know how much contaminated water enters the river and whether the levels are increasing or decreasing. These questions will be answered through additional hydrologic testing and geochemical modeling as part of the SFMP project.

Section IV

MONTICELLO, UTAH, MILLSITE

WATER QUALITY

SAMPLING PROCEDURES

Groundwater and surface-water samples were collected at the Monticello site using a peristaltic pump, a bladder pump, or a Teflon bailer. Samples requiring filtration were filtered through a 0.45-µm filter in line with the collection vessel. The samples were then preserved as required and analyzed according to procedures prescribed in Korte and Ealey (1983), Korte and Kearl (1984), and Environmental Protection Agency (EPA) standards (1979a, 1979b, 1980, 1982a, 1982b).

SURFACE WATER

Characterization of Background

Background surface-water quality has been monitored for some years at the site labeled W-3 in Figure IV-1. This sampling point is located east of the culvert under Highway 163. Upstream samples (site I-1) have also been collected to verify that the W-3 site accurately represents the background water quality of Montezuma Creek (Korte and Thul, 1982, 1983).

From March through November, 1984, surface water at site W-3 was characterized by low levels of toxic elements or mill-tailings-related contaminants. Elements not detected or found in very low concentrations include As, Ba, Cr, Fe, Mn, Mo, Pb, Se, U, V, and Zn. No Ra-226 was detected. The pH was found to be between 6.6 and 8.4; specific conductance was measured at 246 to 732 µmhos/cm, and alkalinity at 105 to 258 mg/l (as $CaCO_3$).

Surface Water Contamination

Permanent surface water on the Government property consists of perennial flow in Montezuma Creek and in the drainage between the carbonate and vanadium piles (drainage designated W-2 on the map in Figure IV-1). There is intermittent water in seeps south of the carbonate and vanadium piles and east of the acid pile. The vanadium and acid pile seeps contain water in the Spring following snowmelt. The seep adjacent to the vanadium pile generally covers an area up to 5 square meters to a depth of 15 to 30 centimeters. The acid pile seep is contained by a small dam and is, when full, approximately four times larger in area than the vanadium pile seep.

The seep adjacent to the carbonate pile forms a small pond covering approximately 15 square meters. This pond contains water throughout the Summer and supports a few cattails; it is the only one of the three seeps that contains water during the dry seasons.

A diversion ditch has been constructed north of the east tailings pile to divert some of the water that would normally flow into the piles. It is hoped that this will effect a decrease in the volume of contaminated water that seeps out of the piles.

Sampling of the seeps was conducted during March 1984. The acid pile seep contained 4 mg/l U, 25 mg/l NO_3-N, and 1900 mg/l SO_4, with a pH of 7.7. The carbonate pile seep contained 1.1 mg/l U, 1.4 mg/l Mo, and 1000 mg/l SO_4, with a pH of 9.4. The vanadium pile seep contained 17 mg/l U, 1.6 mg/l Mo, and 1700 mg/l SO_4, with a pH of 9.0. The last two seeps also contained As and Se concentrations in excess of 1.5 mg/l and 0.4 mg/l, respectively.

Montezuma Creek flows through the middle of the property. Flow is perennial, although it can be quite low during the late Summer. There can also be substantial flooding with high flows, as was observed in the Spring of 1983. Results of previous studies (Korte and Thul, 1982, 1983) indicate that uranium contamination of the creek is observed prior to the point at which the creek traverses the tailings piles. However, concentrations of both molybdenum and uranium are considerably higher off-site, demonstrating that the main contribution of the alluvial aquifer to Montezuma Creek occurs downstream from the Government property.

Montezuma Creek

Seeps from the shallow aquifer are visible along the creek below the drop structure. Creek flow increases for approximately 2 kilometers and is perennial along this stretch. The W-4 sampling site is located approximately 100 meters downstream from the east boundary of the property. Except under conditions of very high flow, as during a storm event or Spring runoff, contamination levels frequently exceed State of Utah standards (see a succeeding subsection, Water-Quality Standards).

Samples have routinely been collected at what is known as the Sorenson site, located approximately 2 kilometers downstream from the Government property. It has been apparent from data comparison that little decrease in contamination is observed between the W-4 site and the Sorenson site. The shallow aquifer is contaminated as far downstream as it has been sampled, and thus maintains high concentrations (0.12 mg/l Mo, 0.25 mg/l U, and 0.51 mg/l V) of the toxic elements in Montezuma Creek for a considerable distance off-site. The downstream water quality of Montezuma Creek is described in detail in last year's environmental monitoring report (Korte and Thul, 1984).

GROUNDWATER

Alluvial Aquifer Upgradient

Shallow-aquifer background groundwater-quality data have been acquired from Wells 19, 44, 43, and 20 (see Figure IV-2). Elements not detected or found in very low concentrations include As, Ba, Cl, Fe, Mo, Pb, Se, V, and Ra-226. Trace elements found in significant concentrations include Mn (1.1 to 2 mg/l), Zn (0.1 to 5.0 mg/l), and U (as much as 0.05 mg/l in two samples). The pH was found to range from 6.8 to 8.3; specific conductance was measured at 550 to 917 µmhos/cm, and alkalinity at 250 to 350 mg/l.

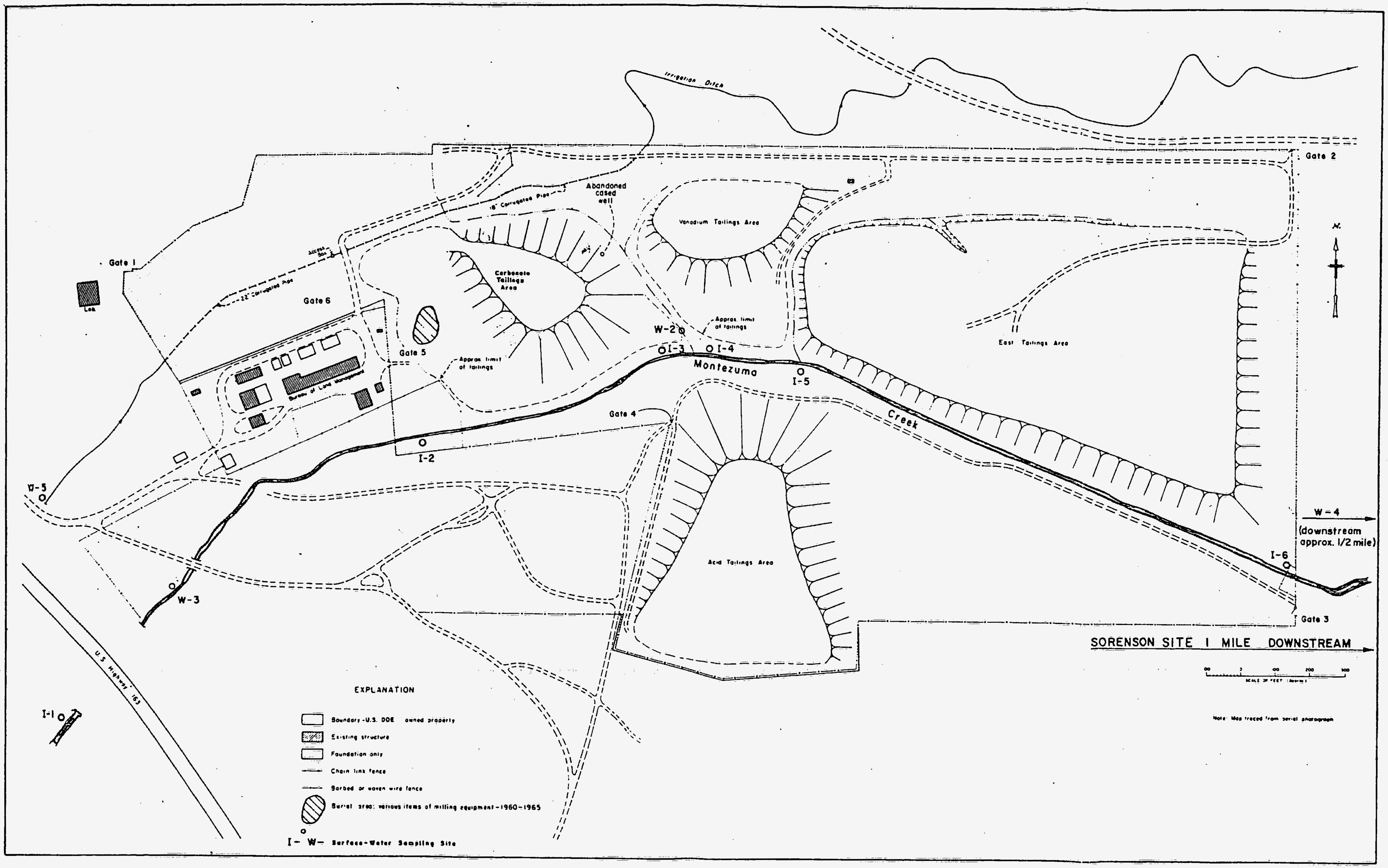
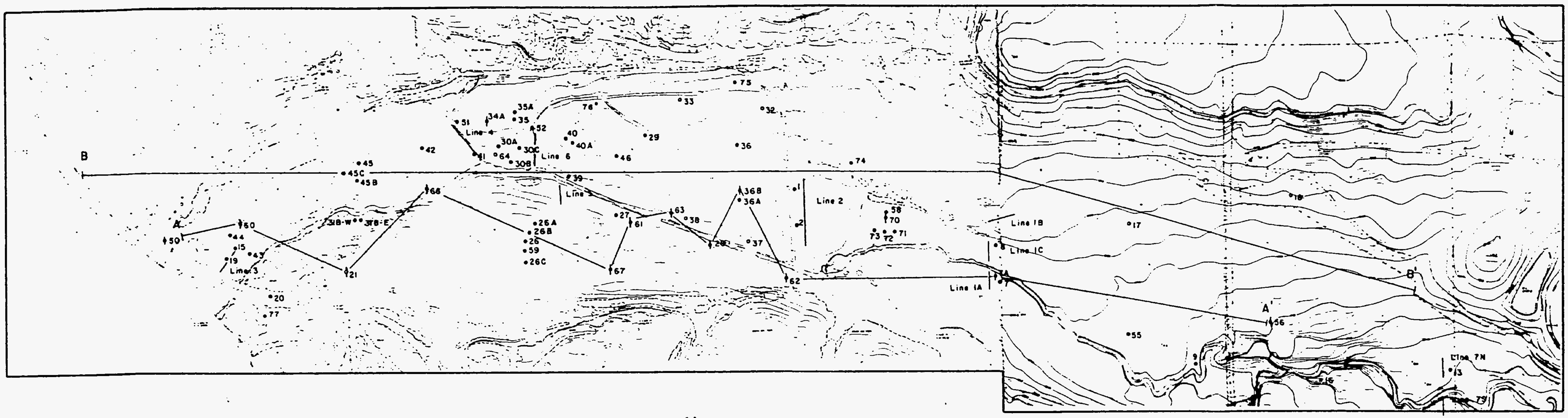


Figure IV-1. Sampling Locations for Surface Water at the Monticello Millsite



EXPLANATION

A-A' Bedrock Cross Section

B-B' Generalized Cross Section

Line — Refraction Seismic Line

• Drill Hole

Core Hole

○ Abandoned Drill Hole

N.

0 300 600 1200 Feet

Figure IV-2. Sampling Locations for Groundwater at the Monticello Millsite

Alluvial Aquifer On-Site

The shallow aquifer is contaminated by the mill-tailings piles (Table IV-1). In general, the highest concentrations, including that of Ra-226 (32 pCi/l in Well 41), are found in the vicinity of the carbonate and vanadium piles. Note that the high uranium content of Well 36A on the east side of the east tailings pile is reflected in off-site Wells 1 and 2 on the private property immediately east of the Government property (Table IV-2).

Table IV-1. Contamination in Shallow On-Site Monitoring Wells

Well No.	Contaminant Concentration[a]										
	As	Cl	Fe	Mn	Mo	NO_3-N	Ra-226	Se	SO_4	U	V
30A	0.03	51	<0.5	1.8	0.08	<5	<2	0.01	361	0.28	0.88
30B	0.14	127	<0.5	2.0	0.5	<5	<2	0.07	520	0.7	4.03
30C	0.12	110	<0.5	1.7	0.42	<5	<2	0.1	464	0.5	3.8
36A	<0.01	122	0.7	12.1	1.1	34	24	<0.01	3600	9.0	<0.05
40A	0.06	110	<0.5	2.6	0.32	<5	10	<0.01	560	0.9	0.42
41	3.9	2060	<0.5	0.86	10.9	50	32	1.9	4680	3.5	122
45B	<0.01	15	<0.5	0.5	0.1	<5	<2	<0.01	190	0.03	<0.05

[a]All results are in mg/l except those for Ra-226 which are in pCi/l. Results represent averages from six samplings made over the period March to November, 1984.

Table IV-2. Contamination in Shallow Off-Site Monitoring Wells

Well No.	Contaminant Concentration[a]								
	As	Fe	Mn	Mo	NO_3-N	Ra-226	Se	U	V
1	0.04	<0.5	3.4	0.45	<5	<2	<0.01	1.9	0.88
2	<0.01	<0.5	1.5	0.25	<5	<2	<0.01	1.6	<0.05
7	<0.01	<0.5	0.15	0.07	<5	<2	0.03	0.42	0.07
8	<0.01	<0.5	<0.1	0.21	<5	<2	0.02	0.36	<0.05
58	<0.01	<0.5	0.2	<0.05	<5	<2	0.03	0.5	0.38
9	<0.01	<0.5	1.1	0.2	<5	<2	<0.01	0.36	<0.05
13	0.02	<0.5	0.11	0.1	<5	<2	<0.01	0.7	<0.05
16	<0.01	<0.5	<0.1	0.0	<5	<2	<0.01	0.14	<0.05

[a]All results are in mg/l except those for Ra-226 which are in pCi/l. Results represent averages from six samplings made over the period March to November, 1984.

Alluvial Aquifer Downgradient

The shallow-aquifer monitoring wells on the private property east of the Government property are contaminated with uranium, molybdenum, vanadium, and selenium. The data presented in Table IV-2 demonstrate that concentrations of these elements remain high throughout the year. This aquifer is the major water source for the creek during the dry months, causing the creek to maintain relatively high levels of contamination during those periods. Some of these wells (9, 13, and 16) are located as far east of the Government property as 1 kilometer, and are still significantly contaminated (Table IV-2).

Resource Conservation and Recovery Act (RCRA) Monitoring

In order to comply with requirements of the Resource Conservation and Recovery Act (RCRA), both the alluvial aquifer and the Burro Canyon culinary aquifer must be sampled quarterly and the samples analyzed for a specified set of contaminants. The first quarterly sampling was performed on 29 October 1984; available results are presented in Table IV-3. For the alluvial aquifer, Well 20 is sampled as upgradient and Wells 1, 2, 8, 36A, and 40A as downgradient (cf. Figure IV-2). For the culinary aquifer, Well 77 is sampled as upgradient and Wells 74, 75, and 76 as downgradient.

As Table IV-3 demonstrates, the highest total organic halogen (TOX) values occur in the alluvial aquifer, both in the background and downgradient wells. Data from future samplings will be examined to determine whether these first results reflect a prevailing pattern; if so, further speciation may be performed on those samples having elevated TOX values. Phenols, herbicides, and pesticides were not detected in any of the samples analyzed for RCRA monitoring purposes.

WATER-QUALITY STANDARDS

The Surplus Facilities Management Program Office has directed that the following standards will apply to the surface-water and groundwater quality at Monticello (White, 1983):

- EPA Standards for Remedial Actions at Inactive Uranium Processing Sites (40 CFR Part 192)
- EPA Safe Drinking Water Act (40 CFR Parts 141, 142, and 143)

In addition, Executive Order 12088 mandates that Federal Government facilities comply with State standards. Thus, the Utah Water Pollution Control Act (1978) must also be addressed with respect to remedial action at the Monticello site.

Surface Water

According to the Utah Water Pollution Control Act, Montezuma Creek must be protected for domestic use (class 1C), aquatic life (class 3A), and agricultural use (class 4). The domestic-use classification is a result of

Table IV-3. Analytical Results for RCRA Monitoring Wells at Monticello

Well No.	Contaminant Concentration[a]										CDT[d] (µmhos/cm)	pH
	TOC[b]	TOX[c]	As	Cl	Fe	Mn	Na	SO_4	NO_3-N	Ra-226		
77	1.0	0.1	<0.01	3	<0.1	0.36	61	98	<5	<2	455	7.4
20	3.6	8.9	<0.01	8	0.25	1.3	28	200	<5	<2	726	6.9
74	1.2	0.03	<0.01	4	0.12	0.18	77	110	<5	<2	503	7.8
8	7.0	0.1	<0.01	130	<0.1	0.05	183	1000	<5	<2	2046	6.6
2	5.1	4.5	<0.01	180	0.1	0.46	545	1400	<5	<2	2898	7.1
1	4.3	5.2	0.05	120	<0.1	3.7	499	920	<5	<2	2142	7.3
75	6.1	0.17	<0.01	5	<0.1	0.05	109	96	<5	<2	340	7.8
76	4.5	0.03	<0.01	4	<0.1	0.05	97	58	<5	<2	403	7.8
36A	5.6	0.76	<0.01	150	2.1	9.7	831	2600	14	17	3564	7.5
40A	6.1	1.9	0.09	130	0.8	4.2	420	790	<5	10	1920	6.9

[a]All results are in mg/l except total organic halogens (TOX) which are in mg/l Cl and Ra-226 which are in pCi/l.
[b]Total organic carbon.
[c]Total organic halogens.
[d]Specific conductance.

drinking water being removed from the San Juan River at the town of Mexican Hat (Reichert, 1983); Montezuma Creek is a tributary of the San Juan.

Table IV-4 compares the average concentrations of the suspected hazardous contaminants found in Montezuma Creek with the applicable water-quality standards. Numerical standards have not been promulgated for some of the elements; thus, the potential violation of Utah's aquatic-life and agricultural-use standards is open to interpretation. A detailed discussion of potential health effects will be included in the Environmental Assessment for the Monticello Millsite, scheduled for completion in June 1985. The paragraphs that follow evaluate the concentrations of individual elements found in the surface water with respect to the relevant numerical standards.

Uranium - The State of Utah has established a standard of 15 pCi/l gross alpha for class 1C waters. Results of analyses of Montezuma Creek demonstrate that uranium is the only alpha emitter found in significant concentrations. Gross alpha, based only on the uranium contamination contributed by the piles, usually exceeds the standard by at least a factor of six for up to 10 kilometers downstream from the site. However, after approximately 6.5 kilometers, there is a natural contribution from the Morrison Formation.

Arsenic - Arsenic contamination is detectable as far downstream as the Sorenson site. However, levels remain below the standards.

Selenium - Selenium concentrations usually exceed the standards for the first 3 kilometers downstream from the site. The highest concentration detected was three times the domestic-use standard, while the typical concentration approximately equals that standard.

Radium-226 - Radium-226 contamination has not been detected in any of the Montezuma Creek samples collected over the past year.

Molybdenum and Vanadium - Neither of these elements is subject to specific numerical standards. However, both are found in concentrations which may impair agricultural use.

Others - No other inorganic species are found in concentrations exceeding applicable State or Federal standards.

Groundwater

In general, contamination in the shallow aquifer is greater than that found in Montezuma Creek (cf. Tables IV-1 and IV-2). Thus, the water is probably unfit for agricultural use. According to the Utah Water Pollution Control Act (1978), the class 1C designation applies if an aquifer contains 'a sufficient quantity [of water] to supply a public system.' Since all of the shallow wells yield only small amounts of water, the class 1C designation is not applicable to the shallow aquifer at Monticello.

Table IV-4. Comparison of Montezuma Creek Contamination and Relevant Water-Quality Standards

Source	Contaminant Concentration (mg/l)[a]							
	As	Fe	Mn	Mo	NO_3-N	Se	U	V
MONTEZUMA CREEK CONTAMINATION								
Background (Site W-3)	<0.01	<0.1	<0.05	<0.05	<5	<0.01	0.06	<0.05
Site W-4	0.02	<0.1	0.12	0.12	<5	0.03	0.25	0.51
Sorenson Site	<0.01	<0.1	0.12	0.09	<5	0.01	0.16	<0.05
WATER-QUALITY STANDARDS								
Utah: Domestic Use (1C)	0.05	b	c	c	10	0.01	c	c
Utah: Aquatic Life (3A)	b	1.0	c	c	c	0.05	c	c
Utah: Agriculture (4)	0.1	b	c	c	c	0.05	c	c
Safe Drinking Water Act	0.05	c	c	c	10	0.01	c	c

[a]Results represent averages from samples taken during six monitoring trips over the period March through November, 1984.
[b]Insufficient evidence to warrant establishment of a numerical standard; limits are assigned on a case-by-case basis (State of Utah, 1978).
[c]No legal guidance.

Summary

State of Utah standards for surface water are clearly violated in Montezuma Creek as a result of contamination from the tailings piles. The shallow aquifer is even more contaminated, but contains too little water to have any potential for beneficial use.

AIR QUALITY

RADON FLUX AND ATMOSPHERIC TRANSPORT

Extensive measurements of radon contamination from the tailings piles were conducted during 1984. These include on-pile, site-boundary, and off-site Track Etch measurements, as well as additional on- and off-pile radon-flux measurements. Results of these measurements are not available at this time, but will be presented and discussed in detail in the Environmental Assessment for the Monticello Millsite, being prepared by Bendix Field Engineering Corporation/Grand Junction Operations and scheduled for completion in June 1985.

AIR PARTICULATES

The background particulate burden in the Monticello area can be inferred from information gathered at rural sites throughout the western United States (Flocchini and others, 1981; Hall, 1981; Korte and Moyers, 1978; Mesa County, Colorado, Health Department, 1979). In two of these studies (Flocchini and others and Mesa County, Colorado, Health Department), data were collected within 50 to 100 miles of Monticello. Results of all of the investigations demonstrate that the average particulate mass in western, rural, high-desert locations is 15 to 25 $\mu g/m^3$. These studies agree that most of the particulate mass is soil material, with only minor contributions of anthropogenic origin. However, determination of contaminants related to uranium mill tailings was not addressed in any of these investigations.

Van De Steeg and others (1982) describe the concentration and distribution of radionuclides in airborne particulates from the Ambrosia Lake uranium district in New Mexico. Average concentrations at background locations were approximately 5 to 10 $\mu g/m^3$ of U-238 and 0.1 to 0.5 pCi/m^3 of Ra-226. These values represent the closest approximation of a historical record for Monticello.

Sampling Method and Results

Inhalable particulate samplers based on the design by Wedding (1982) were installed at the Monticello site. The samplers are Sierra-Anderson Series 300, equipped with constant-flow controllers, mechanical timers, and Series-320-size selective inlets. Flow-rate calibration is accomplished with a Kurz Model 341 electronic mass flowmeter.

Samplers are operated at 40 cubic feet per minute (cfm) for 24 hours, running midnight-to-midnight every sixth day. Sample-collection media are Whatman Number 40 cellulose filters or Pallflex-type 2500 quartz filters.

Wind-rose data collected on-site have clearly identified two principal wind vectors in the area, one to the east and one to the north. Thus, sampling stations were located along these two directions as well as at a background site.

The Background Site is located approximately 0.8 kilometer west of the City of Monticello near the pumphouse building for the city water supply. The intake port for this sampler is 3 meters above ground level. The area west of this site is mostly natural desert and mountainous terrain. There are no nearby industrial activities.

The East Site is located on the eastern edge of the east tailings pile. The sampler was placed on a steel tower such that the intake was mounted approximately 3 meters above ground level.

The North Site is located on the west side of the City of Monticello cemetery grounds. This location is 300 meters north of the tailings area at an elevation 100 meters above the piles. The sampler intake is 4 meters above ground level.

Air-particulate sampling for 1984 was initiated in March. (Sampling had been suspended during the period November 1983 to March 1984 due to inclement weather.) Table IV-5 lists average concentrations for selected elements obtained for the 6-month period March to September. These data indicate a fairly clean air mass at the Background Site.

At the East Site, the radionuclides radium-226 and thorium-230 were detected on several days (June 24 and 30; July 6, 12, and 18; August 29; September 4), with the highest values recorded on September 4 (see Table IV-5). These radionuclides were also detected at the North Site on three of the same days (June 24, July 6, and July 12), although the concentrations were barely above detection limits. A likely explanation for these elevated contaminant levels is the movement of large quantities of contaminated soil into the area directly west of the East Site over the period June through September. This material had been removed from a number of Monticello vicinity properties and was dumped on the east tailings pile. Because of the extremely high values caused by this dumping activity, it is impossible to determine how much, if any, airborne contamination is caused by the original tailings piles.

Table IV-5. Concentrations of Selected Elements in Airborne Particulates

Element	Element Concentration[a]					
	East Site		North Site		Background Site	
	Average	Sept. 4	Average	Sept.4	Average	Sept. 4
Cu	0.018	0.036	0.018	0.017	0.017	0.013
Pb	0.018	0.037	0.015	0.013	0.011	0.006
V	0.003	0.005	0.002	0.001	0.001	0.001
Fe	0.53	2.02	0.256	0.134	0.284	0.129
K	0.434	1.29	0.332	0.135	0.341	0.123
Mn	0.014	0.143	0.007	0.001	0.009	0.001
U	<0.0007	0.0011	<0.0007	<0.0007	<0.0007	<0.0007
Ra-226	<0.0002	0.0011	<0.0002	<0.0002	<0.0002	<0.0002
Th-230	<0.0003	0.0009	<0.0003	<0.0003	<0.0003	<0.0003

[a]Results are in $\mu g/m^3$ except Ra-226 and Th-230 which are in pCi/m^3.

POTENTIAL HEALTH EFFECTS

Population dose commitments and potential toxic effects of nonradiologic contaminants associated with the Monticello site will be discussed in the Environmental Assessment for the Monticello Millsite. Preliminary results indicate that detrimental radiologic health effects are indistinguishable from those resulting from background.

There is some potential for toxic effects from nonradiologic contaminants in the shallow unconfined aquifer and in Montezuma Creek. However, there have been no incidents reported. The potential for toxicity was derived from a comparison of contaminant levels with recommended safe limits as published in the technical literature (e.g., National Academy of Sciences, 1972). For example, the molybdenum concentration in Montezuma Creek for the first 2 kilometers downstream exceeds suggested limits for dairy cattle intake and may always exceed recommended limits for irrigation water. Selenium concentrations generally exceed the suggested limits for protection of dairy cattle and frequently exceed limits for irrigation water. Vanadium concentrations regularly exceed suggested limits for the protection of dairy cattle, aquatic life, and irrigation water. The suggested limits for beef cattle are also exceeded at times. Since the creek is used both for irrigation and for watering livestock, the potential for toxic effects merits further study.

CONCLUSIONS

Hydrologic conditions at Monticello result in the movement of contaminants into the underlying alluvial aquifer and downgradient from the tailings area. Remedial action will address the extensive contamination in Montezuma Creek. This contamination exceeds numerical standards set by the State of Utah and extends for at least 6.5 kilometers downstream from the millsite.

Section V

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